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GEOLOGY.—*Some littoral and sublittoral physiographic features of the Virgin and northern Leeward Islands and their bearing on the coral reef problem.* THOMAS WAYLAND VAUGHAN,[1] Geological Survey.

The Virgin Islands rise above a bank extending eastward from Porto Rico from which they are separated by water up to 17 fathoms deep. The St. Martin group, comprising Anguilla, St. Martin, St. Bartholomew, and a number of islets, lie a little south of east from the Virgins across the Anegada Passage, which exceeds 1000 fathoms in depth. St. Croix is due south of the Virgins across a chasm, a great fault valley, which at a distance of 22½ miles south of St. Thomas attains a depth of 2580 fathoms (15,480 feet). Saba is south of St. Martin. The west end of the St. Christopher Chain, to which St. Eustatius, St. Christopher, and Nevis belong, is south of St. Bartholomew; while Antigua and Barbuda are east of the St. Christopher Chain.

The ocean bottom off the shores of the Antilles shows three distinct types of profiles, and a fourth type is furnished by Saba and other banks. The first is that found off the volcanic islands, such as Saba and the members of the St. Christopher Chain, into the sides of which the sea has cut relatively narrow platforms (see fig. 1).[2] There are suggestions of submerged flats off the northwest end of St. Eustatius and southeast of Nevis.

[1] Published by permission of the Director of the U. S. Geological Survey and of the President of the Carnegie Institution of Washington.

[2] The profiles illustrating this paper were draw by Miss Irene Pistorio, who also drew the contours on the hydrographic charts here discussed.

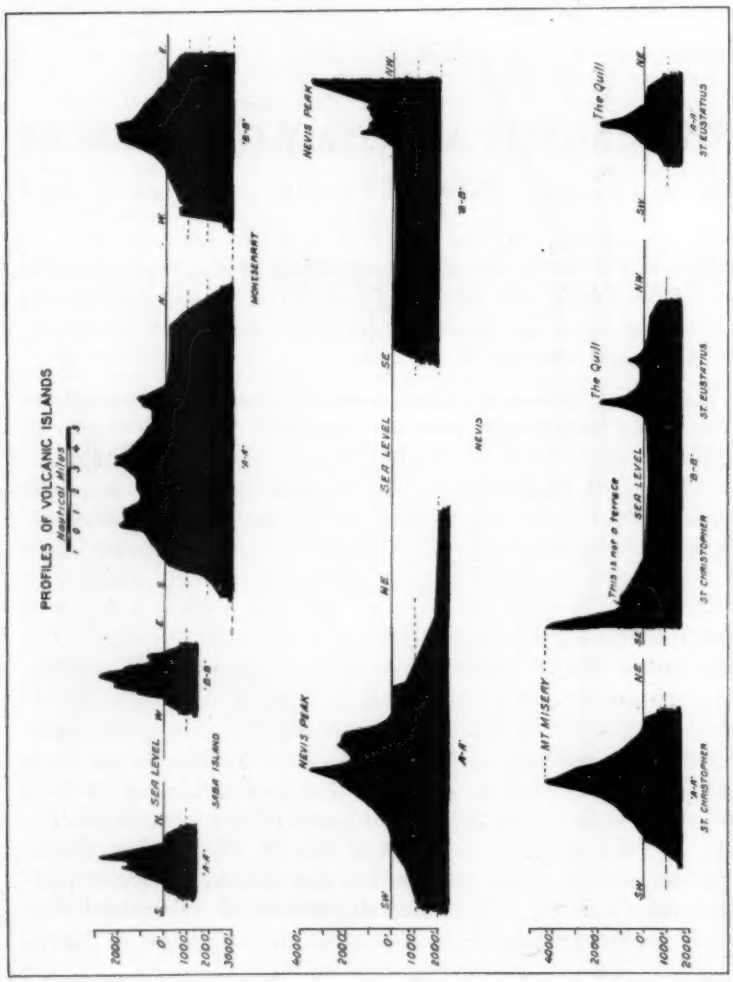


Fig. 1. Profiles of volcanic islands, West Indies. Vertical scale 7 times the horizontal.

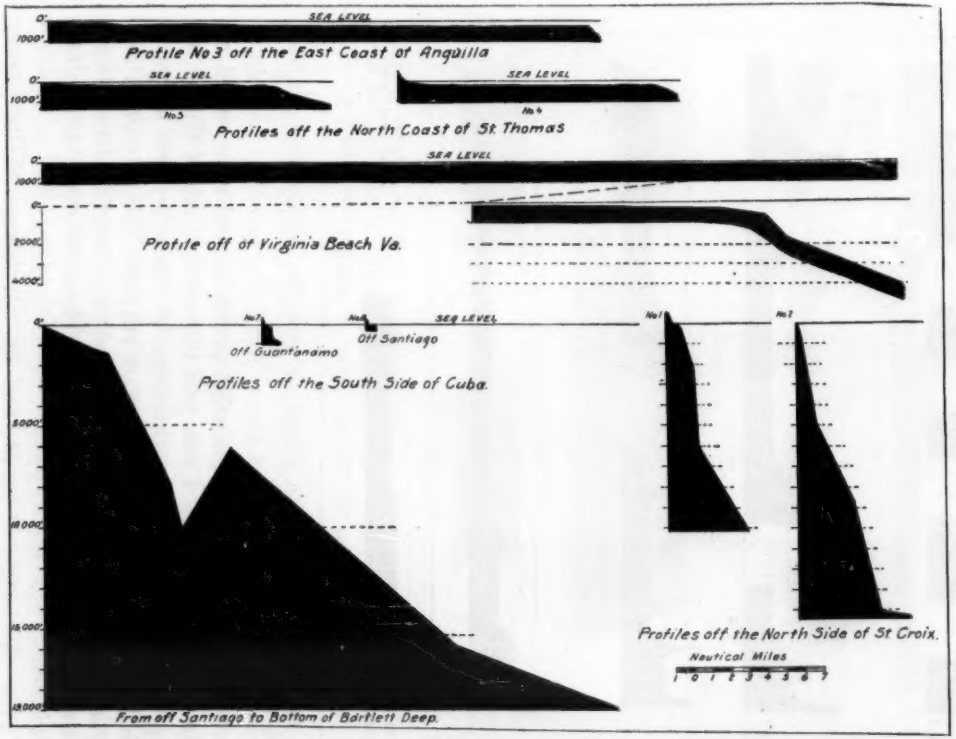


Fig. 2. Profiles off West Indian Islands and Virginia Beach, Va. Vertical scale 7 times the horizontal.

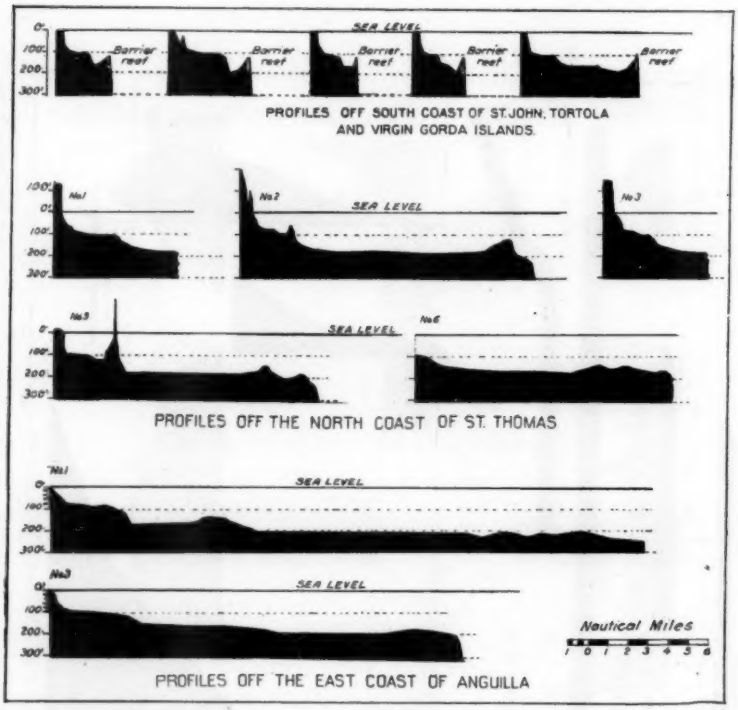


Fig. 3. Profiles off Virgin Islands and Anguilla. Vertical scale 70 times the horizontal.

The second type of submarine profile is well represented off the north shore of St. Croix and the south shore of Cuba (see fig. 2). The precipitous character of these profiles indicates faulting and the geologic structure supports this interpretation. There is a downthrown block between St. Croix and the Virgin Group, and another downthrown block between Cuba and Jamaica.

The third type of profile (see fig. 2), represented by shores off which are extensive shallow flats, occurs where planation agencies have long been active. Here the rocks often, if not usually, dip under the sea at relatively gentle angles.

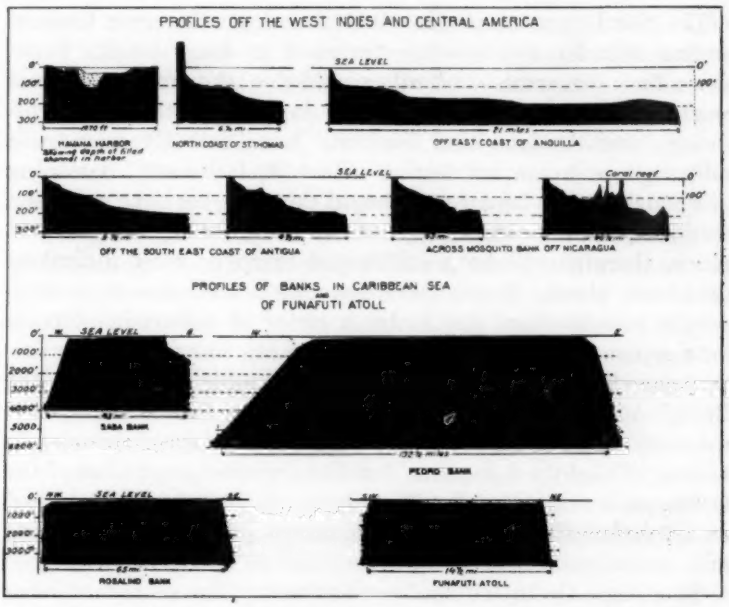

PROFILES OFF THE WEST INDIES AND CENTRAL AMERICA
SEA LEVEL
HAVANA HARBOR
NORTH COAST OF ST THOMAS
OFF EAST COAST OF ANGUILLA
OFF THE SOUTH EAST COAST OF ANTIGUA
ACROSS MOSQUITO BANK OFF NICARAGUA
Coral reef
PROFILES OF BANKS IN CARIBBEAN SEA AND OF FUNAFUTI ATOLL
SABA BANK
PEDRO BANK
ROSALIND BANK
FUNAFUTI ATOLL

Fig. 4. Profiles off West Indies and Central America, of banks in the Caribbean Sea, and of Funafuti atoll. Vertical scales on sides, horizontal distance stated below profiles.

The fourth type of profile is represented by the extensive submerged banks or platforms which have no bordering lands and whose upper surfaces range in depth from 9 to 30 fathoms (54 to 180 feet). Good examples are Saba Bank, southwest of Saba Island; Pedro Bank, southwest of Jamaica; and Rosalind Bank, off Mosquito Bank, which is the Continental Shelf northeast of Nicaragua and Honduras (see fig. 4). That the depth of water on these banks is essentially the same as in many atolls of the Pacific, especially the Paumotus, has been repeatedly pointed out, but apparently the fact has not yet been sufficiently emphasized. The profile of Funafuti atoll in figure 4 is very similar to the profiles of the West Indian banks, which are many times its dimensions.

The third type of profile (that showing submarine terraces around islands) will now be discussed in some detail. From shore line characters and other evidence the conclusion was reached that the Virgin Islands, the members of the St. Martin Group, and Antigua and Barbuda have recently undergone submergence to an amount of about 20 fathoms.[3] Assuming this conclusion to be correct, should the sea level have remained stationary for a period of appreciable length before this submergence, there should be a submerged scarp or facet indicating its former stand; should there have been a succession of temporary stands there should be a series of submarine terrace flats separated by scarps. The available sources of information were the charts of the U. S. Hydrographic Office and of the British Admiralty. The Virgin Bank and the St. Martin Plateau were selected for special study. The charts of the former, on a scale of slightly more than 1 mile to an inch, and that of the latter, on a scale of about 2½ miles to an inch, were contoured on a 2 fathom interval from the shore to a depth of 40 fathoms, and on an interval of 10 fathoms from 40 to 100 fathoms.

The Virgin Group will be described first. The shore line shows indentations indicative of submergence, and that the sea has stood at its present level long enough for alluvial filling of the heads of harbor digitations, while sea-cliffs occur at the ends of promontories. The chart of the nearby sea-bottom shows that south of St. John, Tortola, and Virgin Gorda there are two distinct submerged terraces and a less definite third terrace (see fig. 3). The outer terrace flat lies at depths between 26 and 28 fathoms on its landward and between 28 and 30 fathoms on its seaward margin, and it ranges in width from ½ mile to 3 miles. On its sea-front is a ridge which is inferred to be a submerged barrier coral reef. On its landward side a scarp rises from a depth of 26 to 28 fathoms to about 17 fathoms. Above this scarp is a second terrace flat, which has a depth of 14 to 15 fathoms on its landward and a depth of 14 to 20 fathoms on its seaward face, and ranges in width from one-third of a mile to 2 miles. Apparently the outer margin of this flat also bears

[3] Bull. Am. Geog. Soc., 46: 426–429. 1914.

a coral reef. These are the two principal terrace flats. The scarp separating them is indicated by crowded contours, and chart No. 1832, U. S. Hydrographic Office, shows its continuity for 36 nautical miles or about 1½ land miles farther than from Washington to Baltimore. A third, still higher terrace flat is suggested between depths of 6 and 10 fathoms, above which a fourth terrace may now be in process of formation, but the information regarding these is at present not definite enough to warrant a positive statement. The *continuity* of the upper one of the two well-marked flats needs to be emphasized. It should be noted that east of Virgin Gorda there has been an uptilt.

On the windward (northern) side of St. Thomas, there is an extensive outer flat, bounded on its landward side by a steep escarpment which in places is nearly 160 feet high (see fig. 3). The landward margin of the plain is between 26 and 28 fathoms in depth; the seaward margin has a depth between 30 and 34 fathoms; the width is as great as 10 miles and for distances as great as 8½ miles, in depths between 29 and 31 fathoms, the range in relief of the surface may be as small as 2 fathoms. Its outer margin is cut by reentrants which have bottoms about 40 fathoms deep and simulate hanging valleys. There are also near the outer margin of this flat, banks or ridges the upper surfaces of which are relatively flat, between 17 and 20 fathoms in depth. One of these banks has a total basal width of about 4 miles and a length of more than 5 miles. As its form is not that of a coral reef, it can only be the base of what was an island, which had been reduced almost to a smooth surface by marine planation and then, as indicated by other evidence, submerged. As all the other shoals with one exception are truncated at nearly the same level it seems that most of them should be ascribed to a similar origin. These shoals usually show escarpments between 20 and 30 fathoms on their windward sides and more gradual slopes on the leeward sides. The outer flat on the north side of St. Thomas corresponds to the lower flat on the south side of St. John, Tortola, and Virgin Gorda. Both are submarine plains, which several lines of evidence show were developed when sea-level was about 20 fathoms or slightly more,

lower than now. The escarpment extending from the islands north of Culebra Island, east of Porto Rico, across the Virgin Passage, and along the north side of St. Thomas, and the escarpment on the face of the outlying shoals apparently can be explained in no other way.

The indentations on the outer margin of the outer flat may have been caused by emergence and stream cutting after its formation, or they may be due to initial marginal irregularities which have not been obliterated.

The approximate accordance in level of the tops of the outlying shoals at depths between 17 and 20 fathoms has been mentioned. These summits accord in height with a flat or gently sloping zone, which lies above and nearer shore than the deeper flat and represents the 14 to 20 fathom flat south of St. John and Tortola. It is scarcely represented on the seaward side of the promontories, viz.: Cockroach and Cricket rocks, and Outer Brass and Little Hans Lollick islands. However, it spreads out on the flanks of the promontories and ranges from half a mile to nearly 1½ miles in width; it is separated on its seaward side by a steep slope or escarpment from the deeper flat and on its landward side by a less distinct escarpment, in places about 26 feet in height, from a less developed flat which has a depth of 7 to 10 fathoms. The descent is sudden from the shore to about 6 fathoms which is near the landward margin of the highest submarine flat. This flat, also, is narrow on the tips of the promontories mentioned, but widens on their flanks and along the shores of the main island. The submerged valley in Charlotte Amalia Harbor has a depth of 10 fathoms.

The narrowness or absence of the 14 to 20 fathoms flat on the promontory tips, while it is so well preserved in protected places, especially off the south sides of St. John and Tortola, shows that it is older than the deeper flat and in exposed places was cut away during the formation of the latter, subsequent to the formation of which, after perhaps a brief interval of still lower stand of sea-level, the entire area has been re-submerged, to an amount about the same as that of the initial submergence.

There is doubt as to the interpretation of the 7 to 10 or 12 fathoms flat. In places it seems to be distinct and older than the one next lower, but it may represent the submarine terrace being formed at present sea-level.

According to the physiography of the sea-bottom, the Virgin Islands were joined to Porto Rico during the cutting of the scarp separating the deepest from the next higher flat. The biogeographic evidence shows conclusively that the two were united and have been severed in Recent time by submergence. Stejneger says in his Herpetology of Porto Rico: "It is then plain that the 16 species of reptiles and betrachians found in St. Thomas and St. John form only a herpetological appendix to Porto Rico." Doctor Bartsch informs me that the testimony of the land Mollusca is the same as that of the reptiles and batrachians. The biogeographic evidence substantiates the deductions based on the purely physiographic study.

There are three tiers of coral reefs in the Virgin Islands. They rise above (a) basements 10 fathoms or less in depth; (b) above the outer edge of the 14 to 20 fathoms flat; (c) above the outer edge of the 28 to 34 fathoms flat. As the escarpment within the outermost reef could not have been cut during the presence of such a reef, the flat must be older than the reef and the reef must have developed during subsequent submergence. The flat therefore cannot be due to the growth of the reef.

The members of the St. Martin Group have indented shorelines, seacliffs, and an unusually fine development of bay bars. The relations on the windward side of the St. Martin plateau are similar to those north of St. Thomas (see fig. 3). The outer, deeper flat, from 26 to 36 fathoms in depth, has a maximum length east and west of over 30 miles. It seems composed of two terraces. The scarp on its landward side is distinct and in places is about 50 feet high, in depths between 20 and 28 fathoms, as off the east end of Scrub Island, east of Anguilla Island.

As some of the submerged valleys on the east side of the St. Martin plateau resemble valleys in the Upper Cretaceous Anacacho limestone of Texas, it appears that not only must the scarp line which has been pointed out be interpreted as a former

shore-line but these channels with steep heads must be interpreted as former drainage lines which were subaerially cut and afterwards submerged. The Anacacho limestone in the Brackett quadrangle (of the U. S. Geological Survey) is similar in general character to the limestone which composes Anguilla and Tintamarre.

While the shore-line stood some 20 fathoms lower than now, most of the St. Martin plateau must have been above sea-level. The biologic evidence is in accord with this interpretation, but at present it alone is not sufficient to be decisive.

Antigua is another island with an indented shore-line. It shows typical instances of submerged valleys, and fairly good examples of pouch-shaped harbors. Profiles off the southeast shore are shown in figure 4. These exhibit essentially the same features as the profiles on the Virgin Bank and the St. Martin plateau. If sea-level stood 20 fathoms below its present stand, Antigua and Barbuda would be united. Dr. Bartsch has especially studied the land Mollusca and says: "The land shells show that these islands must have been connected in very recent time."

The deduction that there has been in Recent geologic time submergence to an amount of about 20 fathoms in the Virgin Islands, on the St. Martin plateau, and on the Antigua-Barbuda bank, it seems to me, may be accounted demonstrated.

The upper part of figure 4 shows a set of profiles, all on the same vertical scale. They represent profiles (a) across Havana Harbor, showing depth of filled channel; (b) off the north side of St. Thomas; (c) off the west side of Anguilla; (d) off the southeast coast of Antigua; (e) Mosquito Bank, off Nicaragua. All these profiles indicate a rise of sea-level by an amount of about 20 fathoms. There is in the Virgin Islands and in Cuba clear evidence of a lowering of sea-level by about 20 fathoms, perhaps more, previous to resubmergence. Although the evidence for the other areas is not definite as to the return of sea-level to a former stand, the similarity of the profiles suggests that it also occurred in them. What caused this lowering and subsequent rise of sea-level? As it affects a large area, it appears too wide-

spread to be explained by local crustal movement. The changes in position of strand line here noted are more reasonably explained by a lowering of sea-level due to the withdrawal of water in the Pleistocene ice epochs to form the great Continental glaciers and the raising of sea-level after each epoch through the melting of the glaciers, but the volume of evidence supplied by this area is perhaps not large enough to justify a general conclusion as to the relations of Recent coral reef development to glaciation and deglaciation.

Figure 5 is a map of Florida showing the superposition of upper Oligocene reef corals and coral reefs on the Ocala limestone, which has been traced under and beyond the reefs by means of natural exposures and numerous well borings. The general geologic history of the Floridian plateau has been especially considered by Vaughan[4] and by Matson and Sanford.[5] A paper by Vaughan and Shaw in which the oscillations of the Florida reef tract are discussed is also cited.[6]

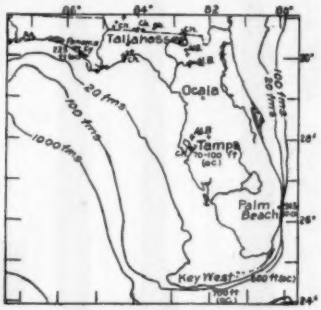


Fig. 5. Map of Florida showing depth in feet below sea-level to upper surface of the Ocala limestone and the location of the superposed upper Oligocene coral reefs and reef corals. Oc=Ocala limestone; Al. B. = fossil reef corals or coral reefs in the Alum Bluff formation; Ch=fossil reef corals or coral reefs in the Chattahoochee and Tampa formations.

A brief comparison will now be made with the Great Barrier Reef of Australia. Figure 6 presents profiles, all on the same horizontal and vertical scales, the latter about seventy times the former. The uppermost profile, along a line running due east from Virginia Beach, Virginia, is introduced for comparison with those of the Continental Shelf and the Great Barrier Reef off the eastern Queensland coast. The Australian profiles are based on the

[4] *A contribution to the geologic history of the Floridian plateau.* Carnegie Inst. of Washington, Pub. 133, pp. 99–185, 15 pls. 1910.

[5] *Geology and ground waters of Florida.* U.S. Geol. Surv., Water-supply Paper 319. Pp. 445, 17 pls. 1913.

[6] Carnegie Inst. of Washington, Year Book No. 14, pp. 232–238. 1916.

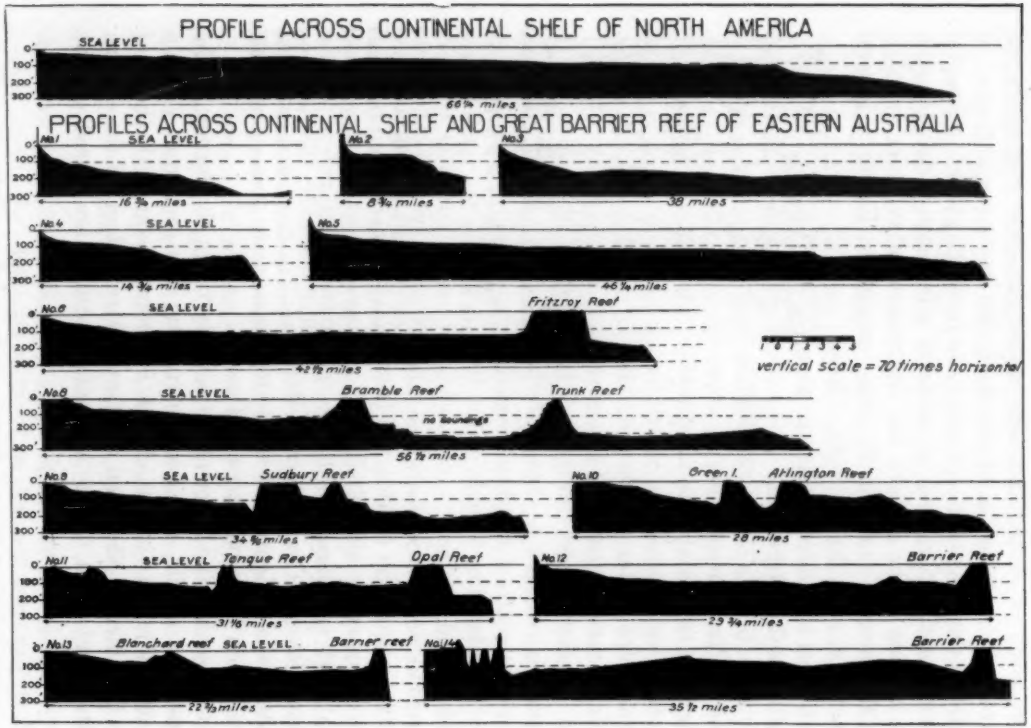


Fig. 6. Profiles off Virginia Beach, Va., and across Continental Shelf off Queensland, Australia. Vertical scale 70 times the horizontal.

British Admiralty charts. The latitude at the intersection of each profile with the shore-line is followed by a statement of the direction of the profile from the shore.

South of the southern end of the Great Barrier Reef.

1. From Burleigh, S. Lat. 28° 4′ 30″, North 73° East.
2. From North Point, S. Lat. 27° 1′ 45″, North 3° East.
3. From Shore east of Leading Hill, S. Lat. 25° 26′ 15″, South 82° East.
4. From base of Sandy Cape, S. Lat. 24° 53′ 40″, North 68° East.

Southern end of the Great Barrier Reef.

5. From Toowong Hill, S. Lat. 24° 22′ 4″, North 45° East, passing between Lady Elliot and Lady Musgrove islands.

Across the Great Barrier Reef.

6. From Rodd Peninsula, S. Lat. 24° 0′ 0″, North 50° East.
8. From Georges Point, Hinchinbrook Island, S. Lat. 18° 25′ 40″, North 72° 30′ East.
9. From Malbon Thompson Range, S. Lat. 17° 7′ 15″, North 68° 30′ East.
10. From Yarrabah Mission, S. Lat. 16° 54′ 30″, North 37° East.
11. From mouth of Daintree River, S. Lat. 16° 18′ 25″, North 78° 30′ East.
12. From half way between Cape Flattery and Lookout Point, S. Lat. 14° 56′ 10″, North 46° East.
13. From Cape Sidmouth, S. Lat. 13° 25′ 45″, North 85° East.
14. From Cape Grenville, S. Lat. 11° 58′ 25″, North 85° East.

These profiles show the continuity of the platform from the area south of the Great Barrier, and that there is an outer, deeper flat about 200 feet deep. As except near its north end the reef stands back from the seaward edge of the Continental Shelf, apparently the idea that the platform was formed by infilling behind the reef may be permanently set aside. The similarity of the conditions here presented to those off Nicaragua and in the West Indies is obvious. The evidence in favor of a shore line between about 25 and 30 fathoms below present sea-level antecedent to Recent submergence is strong, if not conclusive, and supports the deduction that the living barrier reef is growing on what was a land surface in Pleistocene time, an interpretation essentially that proposed by E. C. Andrews in 1902.

The relations around the Pacific Islands off which barrier reefs occur are those of continuous platforms surmounted or margined by discontinuous reefs. These relations indicate the super-

position of reefs on antecedent platforms which have undergone geologically Recent submergence. E. C. Andrews so interprets the conditions of formation of the barrier reefs off the Fiji Islands.[7] It appears to me that the conditions governing the development of the living reefs in the West Indies, Central America, Brazil, Florida and Australia are clear. The reefs have grown upon antecedent basements during Recent submergence. The history of these basements is complex, but during Pleistocene time they stood higher with reference to sea-level than now, their outer margins were remodeled by marine cutting and marine planation, and they were then resubmerged. These changes in height of sea-level accord with the demand of the glacier control theory. It would be remarkable if the conditions in the tropical western Pacific Ocean were exceptional, and the present available facts indicate that they conform to the principles governing reef development in the other areas. Here it should be said regarding the charts for the Pacific, that as they have been made primarily for navigation purposes the depths of lagoons and lagoon channels are often given in a way fairly satisfactory, but on only a few charts can the submarine profiles outside the reefs be determined. The coral reef problem cannot be regarded as satisfactorily solved until the relations in the Pacific islands have been ascertained. In my opinion but little further advance in understanding the problem can be expected from purely biologic studies or from physiographic investigations of the dry land surface alone. As apparently the greatest present need is for more accurate information on the detailed submarine relief in depths between 15 and 50 fathoms, especially on the seaward margins of the platforms, both outside the reefs and off the breaks in the reef lines, the efforts of those interested in such investigations should be concentrated on getting additional hydrographic surveys in coral reef areas.

[7] Am. Jour. Sci. 41: 135–141. 1916.

MINERALOGY.—*Intumescent kaolinite.* W. T. SCHALLER and R. K. BAILEY, Geological Survey.[1]

A sample of kaolinite from eastern Oklahoma was sent in to the Geological Survey for identification by Dr. C. N. Gould of Oklahoma City. According to Dr. Gould, the mineral was received by him from Mr. Tom Wall of Poteau, Oklahoma, who stated that it forms vertical white streaks, one of which appears to be about 20 inches thick, on Back Bone Mountain, about two miles north of Williams, Le Flore County, Oklahoma. The deposit lies near the boundary of sections 2 and 3, T. 8 N., R. 26 E., Le Flore County. The mineral formed small compact lumps with a glistening or fine satiny appearance. Examined microscopically, the material was seen to be pure, homogeneous, and well crystallized in minute hexagonal plates and crystals which had all the appearance of kaolinite. The crystals average about the following dimensions: c axis = 0.02 mm., b axis = 0.04 mm., a axis = 0.06 mm. In testing the fusibility of the mineral it was found to intumesce strongly and as no reference to any intumescent kaolinite was found in the literature the material was examined further for definite identification. It was found to differ from kaolinite only in its intumescence.

The crystals are too small and the birefringence too low for reliable results as to extinction angles and interference figures. The refractive indices were readily determined and are as follows:

α (approx. parallel to c axis) = 1.561
β (approx. parallel to a axis) = 1.563
γ (parallel to b axis) = 1.567
Birefringence ($\gamma - \alpha$) = 0.006

These values are close to those given for kaolinite. Kaiser[2] gives the refractive index as between 1.551 and 1.559, with a birefringence of 0.005–0.006. His values for the refractive indices are slightly lower than those here given. A possible ex-

[1] Published with the permission of the Director of the U. S. Geological Survey.
[2] Kaiser, Erich, Über Verwitterungserscheinungen an Bausteinen I. Neues Jahrb. f. Min. Geol. Pal., 1907: Band 2, 42–64.

planation is that the liquids used were not checked for their indices. It is very essential to redetermine frequently the index of these liquids. It was found, for instance, that our liquids had increased 0.003 from the value determined a year ago. Dick[3] gives the mean index as 1.563 with a birefringence of 0.006. Further Dick gives $(\gamma - \beta) = 0.004$ (on basal plane) and $(\beta - \alpha) = 0.002$, values identical with those found on the material from Oklahoma. The value 1.54, given in some books as the mean index of kaolinite is doubtless too low.

The mineral after intumescence, examined microscopically, is opaque and nearly all of it has lost its perfect crystal outline. Most of the pieces have a form which suggests that during the heating (and intumescence?) the escape of the water took place in such a way as to practically disrupt the crystal structure of the mineral.

The chemical analysis, by R. K. Bailey, gave the results shown under (1), and for comparison under (2) is given an analysis of kaolinite from Saitzewo near Nikitowka (Donez-Becken) by Samojloff,[4] and under (3) the theoretical composition.

	(1)	(2)	(3)
SiO_2	46.55	46.51	46.50
Al_2O_3	38.90	39.45	39.56
H_2O[a]	14.04[b]	14.10	13.94
	99.49	100.06	100.00

[a] Loss on ignition.

[b] Average of the two determinations, 13.97 and 14.10.

A comparison of the figures given above shows the chemical identity of the mineral from Oklahoma with kaolinite. The water in it apparently behaves normally, for it was found that the total loss on heating the mineral to 330° was insignificant, the total loss of water being 0.09 per cent at 145°, 0.11 per cent at 220°, and 0.12 per cent at 330°.

[3] Dick, A. B., Supplementary notes on the mineral Kaolinite. Mineral Mag. **15**: 124–127. 1908.

[4] Samojloff, J., Über das Wasser des Kaolinits. Bull. Acad. St. Petersburg, **3**: 1137–1152. 1909.

BOTANY.—*Tidestromia, a new generic name.* PAUL C. STANDLEY, U. S. National Museum.[1]

The three species of Amaranthaceae, tribe Gomphreneae, generally known under the name Cladothrix form a very natural and well defined genus. All are natives of the more arid regions of the western and southwestern United States and northern Mexico, two of them being rather local in their distribution, the third, however, ranging from Kansas and Utah to Texas and to Zacatecas and Sinaloa in Mexico. All three are much alike in general appearance, but they differ constantly among themselves in details of floral structure. The genus is distinguished from all the other genera of the Gomphreneae by having the flowers merely glomerate rather than regularly capitate or spicate. Moreover, the leaves subtending the inflorescence become indurate and more or less connate in age, so as to form a sort of involucre.

The oldest and best known species was published by Nuttall in 1820 as *Achyranthes lanuginosa*. In 1849 it was transferred by Moquin to *Alternanthera*. Watson in 1880 established the genus *Cladothrix*, including not only this species but another described by Torrey in 1859 as *Alternanthera suffruticosa*. The first appearance of the generic name *Cladothrix* in literature is in 1849, when Moquin cites a manuscript or herbarium name of Nuttall, *Cladothrix lanuginosa*, as a synonym of his own *Alternanthera lanuginosa*. The mere citation of the generic name in synonymy would not, of course, give it any standing under either of the codes of nomenclature now followed by most botanists and *Cladothrix* when used in this connection must, consequently, date from 1880. Unfortunately for the maintainance of this name in the Amaranthaceae a genus *Cladothrix* of the Schizomycetes had been proposed by Cohn in 1875. Cohn's genus is properly published and is generally accepted by mycologists. It is evident, therefore, that the name *Cladothrix* can not be maintained in the Amaranthaceae and that another must be subst tuted for it. Since none is available, the writer proposes the

[1] Published by permission of the Secretary of the Smithsonian Institution.

name *Tidestromia*, given in honor of Mr. Ivar Tidestrom, an indefatigable student of the plants of the United States, who has given many years to systematic herbarium and field studies of the plants of many parts of our country, especially of Maryland and Virginia, California, Arizona, and Utah.

TIDESTROMIA Standley, nom. nov.
Cladothrix Nutt.; Moq. in DC. Prodr. **13**[2]: 359. 1849, as synonym; S. Wats. Bot. Calif. **2**: 43. 1880.

Tidestromia lanuginosa (Nutt.) Standley.
Achyranthes lanuginosa Nutt. Trans. Amer. Phil. Soc. n. ser. **5**: 166. 1820.
Alternanthera lanuginosa Moq. in DC. Prodr. **13**[2]: 359. 1849.
Cladothrix lanuginosa Nutt.; Moq. in DC. Prodr. **13**[2]: 360. 1849, as synonym; S. Wats. Bot. Calif. **2**: 43. 1880.

Western Kansas to southeastern Utah, south to Arizona, western Texas, and Zacatecas and Sinaloa, Mexico.

Tidestromia oblongifolia (S. Wats.) Standley.
Cladothrix oblongifolia S. Wats. Proc. Amer. Acad. **17**: 376. 1882.
Cladothrix cryptantha S. Wats. Proc. Amer. Acad. **26**: 125. 1891.

Southeastern California to western Nevada and Arizona.

Tidestromia suffruticosa (Torr.) Standley.
Alternanthera suffruticosa Torr. U. S. & Mex. Bound. Bot. 181. 1859.
Cladothrix suffruticosa S. Wats. Bot. Calif. **2**: 43. 1880.

Western Texas and southern New Mexico to Coahuila, Mexico.

ABSTRACTS

Authors of scientific papers are requested to see that abstracts, preferably prepared and signed by themselves, are forwarded promptly to the editors. Each of the scientific bureaus in Washington has a representative authorized to forward such material to this journal and abstracts of official publications should be transmitted through the representative of the bureau in which they originate. The abstracts should conform in length and general style to those appearing in this issue.

TERRESTRIAL MAGNETISM.—*Results of observations made at the United States Coast and Geodetic Survey Magnetic Observatory at Cheltenham, Md., 1913 and 1914.* DANIEL L. HAZARD. U. S. Coast and Geodetic Survey Serial Publication No. 19. 1915.

This publication is in continuation of the series giving the results obtained at the Cheltenham magnetic observatory since its establishment in 1901. It contains a summary of the monthly determinations of the scale-values of the horizontal intensity and vertical intensity variometers; the base-line values derived from the weekly absolute observations; diurnal variation tables for the magnetic elements D, H, and I, the total force F, and the rectangular components X, Y, Z; hourly values of D, H, and Z, together with daily and hourly means for each month; a tabulation of the earthquakes recorded on the seismograph; a list of the magnetic disturbances of considerable magnitude and reproductions of the magnetograms showing the more marked disturbances. Attention is called to the fact that beginning with 1913 intensity results obtained by this Bureau have been reduced to the international standard of the Department of Terrestrial Magnetism of the Carnegie Institution of Washington. Published results for earlier years must be diminished by one part in a thousand to reduce them to that standard.

D. L. H.

GEOLOGY.—*A peculiar oölite from Bethlehem, Pennsylvania.* EDGAR T. WHERRY. Proceedings of the U. S. National Museum, **49**: 153–156, pl. 40–41. Aug. 13, 1915.

The material described occurs in a quarry in magnesian limestone. In one layer the oöids are divided parallel to the bedding into a light

and dark portion, the latter being the lower. Analyses of the rock of this bed and of oöids which have weathered out are given. By calculating the mineral compositions from these, and also the composition of the matrix, assuming that the oöids make up half the rock, it is shown that the oöids are notably higher in dolomite, quartz, kaolin, limonite, and carbon, and lower in calcite and siderite than the matrix. This oölite has probably formed by solution of original aragonite, causing the insoluble carbon and nuclei to fall to the bottom of the cavities; secondary dolomite subsequently filled the latter; and still later the carbon precipitated some pyrite, which has altered to limonite. Figures are given to bring out the various stages of the process.

E. T. W.

GEOLOGY.—*An ancient volcanic eruption in the upper Yukon Basin, Alaska.* STEPHEN R. CAPPS. U. S. Geological Survey Prof. Paper 95-D, pp. 59–64, with text figure and illustrations. 1915.

In the upper Yukon Basin there is a persistent and widespread layer of volcanic ash, commonly overlain by a few inches or a foot or two of soil, silt, or vegetable humus, but in places appearing in great drifts or dunes devoid of vegetation. In general the ash follows closely the present topography, and, although locally overlain by recent stream deposits, is much younger than the glacial materials deposited during the last great period of glaciation. In thickness, the ash ranges from a thin film, at the borders of the area within which it is known, to several hundred feet near the point from which it is thought to have been ejected. It covers a known area of about 140,000 square miles and the estimated volume of the ash is about 10 cubic miles. Microscopic study shows the ash to be an andesitic pumice.

On White River a stream bluff shows the ash to be covered by 7 feet of peat. An estimate of the rate of accumulation of the peat there, gives a figure of approximately 200 years to the foot of peat. On that basis the volcanic eruption that caused the ejection of the ash took place some 1400 years ago.

S. R. C.

PROCEEDINGS OF THE ACADEMY AND AFFILIATED SOCIETIES

THE PHILOSOPHICAL SOCIETY OF WASHINGTON

The 761st meeting was held on October 30, 1915, at the Cosmos Club. President Eichelberger in the chair, 33 persons present.

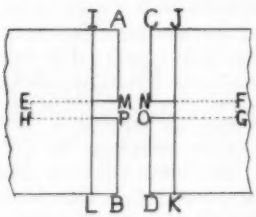
Regular Program

Mr. F. E. Fowle presented a paper on *The transparency of air and water vapor.* Radiant energy ($e_{o\lambda}$) coming through the air from a heavenly body suffers five losses: 1, non-selective, as to wave-length, in the permanent gases of the air; 2, non-selective associated with water vapor; 3, selective in the permanent gases; 4, selective in the water vapor; 5, losses due to the dust. The losses (1) have been shown to be due to the scattering by the molecules of the air and may be computed accurately from the number of molecules in the path; it is expressed by coefficients, $a_{a\lambda}$ (Astrophysical Journal, **40**: 435. 1914; **38**: 392. 1913). The losses (2) are greater than would be expected from the number of molecules of water vapor and are treated in the same paper; they are expressed by coefficients, $a_{w\lambda}$; coefficients for (1) and (2) vary slowly with the wave-length. The losses (3) and (4) are treated in detail in the present communication. The first are practically only in bands of limited wave-lengths and are expressed empirically as a function of the length of path, m, through the air. The losses (4) are similar to (3) but are expressed as a function of the amount of water vapor, w, in the path. The losses (5) due to dust vary at sea level from day to day but are nearly invariable with the wave-length in the region considered here. At Washington they may vary on good days from 3 to 11 per cent or more; above an altitude of about 1000 meters they are generally negligible. The resultant energy may be expressed by $e = e_{o\lambda}\left(a_{a\lambda}^{w}a_{aw}\right)^{m}$. Tables were given showing the losses from the incomng solar energy in calories and per cents due to scattering and absorption for sea level and other altitudes, various amounts of water vapor and zenith distances of the sun; also percentage absorptions due to water vapor at various wave-lengths and formulae for computing the various losses for particular cases.

Discussion: Mr. C. A. Briggs cited a practical application of absorbing power of water vapor by the use of a steam curtain before doors of steel-heating furnaces. Messrs. Swann, Wells, and Bauer asked regarding presence of dust and possible effects at higher altitudes. Mr.

HUMPHREYS referred to the assumption of three regions of dustiness which offers the easier explanation of sky polarization measurements, viz: (1) lower atmosphere hardly reaching the altitude of Mt. Wilson and a region of large dust particles; (2) region of smaller dust particles extending from (1) to an altitude of about two miles, about the height of the ordinary convection clouds, and (3) thence to highest limit of convectional atmosphere and under surface of isothermal region and beyond, ordinarily very free of dust; region (1) would be most effective in scattering. Mr. Fowle noted that the losses at altitudes above 1000 meters were practically nothing, probably ½ per cent. Messrs. C. A. BRIGGS and PRIEST referred to certain anomalous halo phenomena which Mr. HUMPHREYS explained as well-known cases discussed in works on meteorological optics.

Mr. I. G. PRIEST then spoke on *A simple spectral colorimeter of the monochromatic type*. The possibility of so-called "monochromatic color analysis" is due to the experimentally observed fact that any color sensation (except purples) can be "matched" by the sensation caused by a suitable mixture of some one monochromatic light with white light. From a philosophical point of view, this is the most natural and the simplest method of defining a color, but the experimental difficulties and uncertainties of putting it into practice have been considerable. The chief trouble has been due to the necessity of making a photometric comparison between colored light and white light in each color determination. The purpose of the present device is to eliminate this difficulty. The novel and essential feature of the instrument is the system of slits shown in the diagram.



A B C D is a bilateral slit the width of which can be adjusted and measured by a micrometer screw. *E F G H* is a slit cut in the jaws of slit *A B C D* and perpendicular to it. (Actually, the jaws of slit *A B C D* consist of four wings, adjustable on two plates so that the width of the slit *E F G H* can be adjusted by sliding.) *I J K L* is a bilateral slit similar to *A B C D* with its jaws sliding on the jaws of the latter and placed so that their center-lines are coincident. This slit system is mounted in the focal plane of the collimator of a spectroscope so that the slit *E F G H* has the ordinary position of a spectroscope slit; and provision is made for moving the whole system in its own plane, in the direction *A B* in such a way that the displacement can be measured. The whole slit system is illuminated by a uniform white diffusing surface. A slit parallel to the direction *E F* is placed in the focal plane of the observing telescope of the spectroscope; and observations are made with the eye at this slit. "Dominant hue" is varied by displacement of the slit system in the direction *A B* and is determined by the position of the slit *E F G H*. "Purity" is varied by varying the relative widths of the slits *A B C D* and *I J K L* and is

computed from these slit widths, the ocular slit width, the width of *E F G H*, the "visibility" function, and the dispersion. Comparison with a sample is made by means of a Lummer-Brodhun cube before the objective of the observing telescope. Relative "brightness" is determined by relative slit widths. Scale values of slit width *A C* can be changed by means of neutral absorbing films covering *A C N M* and *B P O D* and not covering *E F G H*. This instrument was planned in April, 1915. The new slit system has been constructed, mounted, and tried qualitatively with improvised accessory apparatus. A complete instrument adapted to precise work is now to be designed and constructed, after which quantitative tests of its functioning will be undertaken.

INFORMAL COMMUNICATIONS

Mr. I. G. PRIEST exhibited a newly-designed slide-rule for the rapid computation of the ratio $\tan\vartheta/\tan\lambda$ where the angles have values between 6° and 84°; this slide-rule is particularly useful for laboratory reductions of observations with Marten's photometer and the Koenig-Marten spectrophotometer. Mr. Priest also exhibited a graphical device designed to evaluate equations of the form $y = x^n$ for values of x and y between 0.01 and unity and for values of n between about 0.1 and 10; this device is especially useful and permits rapid computation of transmission for a given thickness when the transmission for some experimental thickness of material is known.

Mr. J. A. FLEMING exhibited a combined magnetometer and earth inductor with a portable galvanometer of the Kelvin type for field use designed and constructed by the Department of Terrestrial Magnetism of the Carnegie Institution of Washington and spoke of some severe field trials showing the availability of this instrument for such use. The high degree of accuracy attainable was indicated by a résumé of recent observatory intercomparisons of magnetic standards using an instrument of this type at Eskdalemuir in Scotland, Kew, Greenwich, and Stonyhurst in England, Cheltenham, Maryland, and Honolulu, Hawaii; these results indicate a readily attainable absolute accuracy of 0′.2 to 0′.3 in declination and inclination and about one five-thousandth part or less in horizontal intensity. The work reported on is the first practical successful application to field use of the earth inductor. Mr. Bauer, discussing this communication, referred to the great improvement effected in magnetic instruments since his comparisons of observatory standards in 1899, and to the work of Schering at Darmstadt about 1899 with an earth inductor and galvanometer of moving-coil type which was used with great inconvenience at field stations but could not be considered practically applicable for field work.

Mr. F. E. WRIGHT stated that in his work with microscopes he had found that the better position of the plane of vibration of the polarizer is parallel to the vertical cross-hair of the eyepiece when observations are made in the early morning or late afternoon and parallel to the horizontal cross-wire at noon. (Journ. Wash. Acad. Sci. **5**: 641. 1915.)

Mr. H. L. CURTIS reported on a method to measure the thickness of a moisture film which forms on a metallic plate by determining the increase of capacity caused by the deposit between two metallic plates.

Mr. W. J. HUMPHREYS spoke on the cause and results of a terrific explosion outside of a 250-gallon tank of "casing-head" gasoline, an especially volatile gasoline, in south Oklahoma, due to volatilization of the gasoline because of exposure to the heat of the sun and carelessness in opening the screwcap over the dome of the tank instead of applying some cooling agent, as water, to reduce the vapor tension inside the tank. Some curious effects on nearby structures, due to the explosion, were detailed.

The 762nd meeting was held November 13, 1915, at the Cosmos Club; President Eichelberger in the chair; 52 persons present.

REGULAR PROGRAM

Mr. D. L. HAZARD presented a communication on *The magnetic work of the U. S. Coast and Geodetic Survey*. The growth of the work to meet the needs of the navigator and surveyor was traced from the reorganization of the Coast Survey in 1843 to the present day, and showed the progress made in the systematic magnetic survey of the United States, begun in 1899. Since that date an average of about 250 new stations and 75 repeat stations have been occupied annually. The first stage of the survey, the establishment of a network of stations 25 or 30 miles apart, is nearly completed as far as the accessible portion of the country is concerned, and the investigation of areas of local disturbance is in progress. The work on land has been supplemented by observations at sea on the vessels of the survey. The observations at repeat stations have supplied the data needed to determine the change of the earth's magnetism with time. Magnetic observatories have been in continuous operation at Cheltenham, Md., since 1901; Honolulu and Sitka since 1902; Vieques, P. R., since 1903; Baldwin, Kansas, from 1900 to 1909, and Tucson, Arizona, since 1909. The results are published as promptly as possible in suitable form to meet the varying demands. The success of the work is due largely to Charles A. Schott, for 50 years chief of the Computing Division, and to Dr. L. A. Bauer, inspector of magnetic work from 1899 to 1906.

Discussion: Mr. W. BOWIE stated that this work was an excellent example of applied science or engineering and praised the comprehensive and systematic scheme followed which supplies both theoretical and practical needs; the prompt publication of results is an admirable feature.

Mr. R. L. SANFORD then gave an illustrated paper on *Uniformity of magnetic test bars*. This paper dealt with the examination of test bars for magnetic uniformity, the nature of non-uniformities that commonly exist in such bars and their effect on the accuracy of magnetic measurements. All precision methods for magnetic measurement on straight bars assume uniformity along the length of the specimen. If this assumption is not met, errors are introduced which are impossible

to calculate and may be of considerable magnitude. It is therefore important that bars, which are to be used as standards for comparison of different methods, or whose properties it is desired to measure with high accuracy, should be examined for uniformity. A method was described which clearly indicates the position, nature, and magnitude of non-uniformities which exist in a test bar. Curves were given showing the effects of non-uniformities on the accuracy of magnetic measurements. Such results naturally lead to a consideration of the possibility of examining ferrous material for soundness and the detection of flaws. Curves were given showing some of the possibilities in this direction.

Mr. J. H. DELLINGER then spoke on *Rationalization of the magnetic units*. There are two distinct sets of magnetic units in common use. The first set consists of the *c g s* units, which are consistent with the ordinary electromagnetic equations. The second set involves the use of the ampere-turn, which introduces certain changes into the equations. In the first set of units, the current use of the name "gauss" both for the unit of induction and the unit of magnetizing force is questionable. The two quantities are sometimes looked upon as physically the same. There are preponderating reasons, however, for considering them to have an essentially different nature, induction corresponding to the magnetized state of the medium, and magnetizing force being the agency tending to produce that state. The double use of "gauss" is an inconvenience in practice. There have been various proposals from time to time to rationalize the units, i.e., to use units such as to redistribute the factor 4π in the equations. The first proposal, that of Heaviside, had much to recommend it but required a radical change of all the electric and magnetic units. Subsequent proposals have involved less change of existing units, but have all had the disadvantage of incorporating 4π in the value of permeability of vacuum. It is pointed out herein that the use of the ampere-turn leads to a rationalized set of units, without either of these disadvantages.

Discussion: Messrs. SWANN, SILSBEE, and ROSA discussed this communication. Such proposals for rationalization are of distinct value to emphasize the sometimes illogical designation of units; the advisability, however, of radical changes from the existing systems is to be questioned since it is difficult to revolutionize practice. Although the two systems of magnetic units sometimes cause ambiguity, simplification as proposed would lead probably to greater confusion, particularly so because of radically different usage by investigators. The incorporation of the factor 4π is quite natural since it has a physical significance in distribution of force over a spherical surface. Mr. Rosa suggested that an International Committee on units and nomenclature is desirable.

INFORMAL COMMUNICATIONS

Mr. F. E. WRIGHT exhibited a graphical device for solving equations of the general form $A = B \cdot C$. (Published in full in Journ. Wash. Acad. Sci. **6**: 1–3. 1916.)

J. A. FLEMING, *Secretary*.

THE BIOLOGICAL SOCIETY OF WASHINGTON

The 545th meeting of the Biological Society of Washington was held in the Assembly Hall of the Cosmos Club, Saturday evening, November 20, 1915; called to order by President BARTSCH with 50 persons present.

On recommendation of the Council LEO D. MINER, E. O. WOOTON, A. M. GROVES, all of Washington, D. C., were elected to active membership.

Under the heading Brief Notes: Mr. LEWIS RADCLIFFE called attention to recent efforts of the Bureau of Fisheries in rearing shad in ponds. Young fish thus raised attained twice the size of those of the same age in their natural environment. Specimens of both kinds were exhibited.

The regular program consisted of three papers, as follows: FREDERICK KNAB, *The dispersal of some species of flies;* ALEX. WETMORE, *Notes on the habits of the duck hawk;* ELMER D. MERRILL, *Geographic relationships of the Philippine flora.*

The 546th meeting of the Society was held in the Assembly Hall of the Cosmos Club, Saturday evening, December 4, 1915; called to order by President Bartsch, with 55 persons present.

On recommendation of the Council Dr. R. W. SHUFELDT, Washington, D. C., and ARTHUR DEC. SOWERBY, Tien Tsin, were elected to active membership.

On recommendation of the Council the following resolutions were read and adopted:

Whereas: Dr. George M. Sternberg, former Surgeon General of the U. S. Army, a distinguished worker in the biological sciences as applied to medicine, long time an active member of the Biological Society of Washington and its President during the years 1895 and 1896, has passed from this life, therefore be it

Resolved: That the Biological Society of Washington keenly regrets his death and offers its warmest sympathy to Mrs. Sternberg, and will always be grateful to his memory for the important part which he took in the affairs and discussions of the Society and for the distinction which his eminent name adds to its list of past Presidents.

Signed, L. O. HOWARD,
FREDERICK V. COVILLE,
PAUL BARTSCH.

Under the heading Brief Notes, Exhibition of Specimens: Dr. O. P. HAY exhibited the skull of a walrus from the southern Atlantic coast of the United States and called attention to other specimens of walrus from localities now far south of its present range. It was Dr. Hay's opinion that the walrus had followed the retreating ice sheet northward. Dr. L. O. HOWARD called attention to the cluster-fly (*Pollenia rudis*), an insect resembling the house fly but collecting in houses in autumn and leaving a yellow stain when crushed. Its life history was unknown until recently, a foreign entomologist having now shown that the

larvae are parasitic in earthworms in France. Dr. Howard is having large numbers of earthworms examined for such larvae, but so far without success. He hoped that anyone finding any grubs parasitic in earthworms would communicate with him.

The first paper of the regular program was by Dr. CHARLES H. T. TOWNSEND, "*Identification of the stages in the asexual cycle of Bartonella bacilliformis, the pathogenic organism of verruga, and their bearing on the etiology and unity of the disease.*" (Published in full in this Journal, **5**: 662–667, December 19, 1915.)

The second and last paper of the program was by A. A. DOOLITTLE, "*The Mississippi River dam at Keokuk, Iowa: Its effect upon biological conditions, especially those of the plankton.* The speaker stated that the Bureau of Fisheries has been examining the new conditions caused by the damming of the Mississippi River at Keokuk, Iowa, to develop electric power. The water is raised to 40 feet above 0 of the river gauge at Keokuk, that is, to the 525-foot level above sea. The water power company must maintain the lake between the 519 and 525-foot levels. The effect of the dam runs out at Oquawka, Ill., 54 miles from Keokuk. In the lower third of its course Lake Cooper, as the impounded waters are called, fills the gorge of old Des Moines Rapids. In the middle third of its course is the greatest lateral expanse, 4 miles or more, covering much island and farm lands. Forests are removed from only a little of the submerged area. Water persicaria seems to be the only water weed establishing itself in great quantity. In the upper third the threatened banks are being enclosed by levees and will be drained by pumping stations. Tributaries are filled for some distance from the river-lake, the larger ones being navigable for upwards of 3 miles in small launches.

There are present the usual characteristics of a river lake: increased regularity of water stages; decreased current; decreased turbidity; establishment of rooted aquatic plants. The most immediate effects of economic importance, biologically, are the destruction of the famous mussels of the rapids, and the interference with the usual passage of fish up and down the river, especially the periodic migrations.

The dominant zooplankton were several species of Entomostraca (*Moina, Diaphanosoma,* and *Cyclops viridis);* the phytoplankton included *Conferva* spp., *Anabaena* spp., and *Clathrocyctis.* Estimates of the abundance of plankton were based upon the cubic yard. Above the influence of the dam about 50 entomostracan individuals constituted the plankton, with traces of algae. At Keokuk this was increased in July to 1500 individuals, in August to 270,000 (volume estimated at 26 cc.), and in September to 1500. Green algae measured 0.14 cc. in July, 29 cc. in August, and 5 cc. in September. Blue-green algae measured traces in July, 2.6 cc. in August, and the same in early September. Below the dam at the maximum for the season the run-off contained 3,000 Entomostraca per cu. yd., 1.17 cc. green algae, and traces of blue-greens, a marked enrichment over that of normal river conditions. In weedy waters, additional heavy-bodied Ento-

mostraca occurred (*Sida, Scapholeberis, Simocephalus*), varying in numbers with the density of growth to a maximum of 178,000 individuals, with estimated volume of 23 cc. per cubic yard.

Streams and sloughs filled with back flow from the lake "ripened" earlier than the main lake body, and contained upwards of 50,000 Entomostraca per cu. yd. in July, with less, usually, in August. Algae were less than in the lake. Where tributaries were filled by their own waters, plankton was of different character. When in flowing streams often protozoans (*Euglena*) or rotifers (*Asplanchna*) were dominant, with little algae. When tributaries were filled with seepage water the plankton again was of special character, holozooplanktonic, with one or another Entomostracan species dominant, as *Cyclops leuckarti* and *Diaptomus* spp. Some of these characteristic forms could be traced into the main stream, but they did not survive. It is evident that there is a vast increase of fundamental food for some species of fishes.

The paper was illustrated with map, diagram and slides showing the conditions existing in the summer of 1914. It was discussed by the Chair, and by Messrs. COKER, MARSH, and WILLIAM PALMER.

The 547th and 36th annual meeting of the Society was held in the Assembly Hall of the Cosmos Club, Saturday, December 18, 1915; called to order by President Bartsch, with 27 persons present.

On recommendation of the Council the following persons were elected to active membership: H. R. ROSEN, U. S. National Museum; MISS VIRGINIA BOONE, U. S. National Museum; IRA N. GABRIELSON, Biological Survey; JAMES SILVER.

Annual reports of officers and committees were submitted.

Election of officers for the year 1916 resulted as follows: *President*, W. P. HAY; *Vice-Presidents*, J. N. ROSE, A. D. HOPKINS, HUGH M. SMITH, and VERNON BAILEY; *Recording Secretary*, M. W. LYON, JR.; *Corresponding Secretary*, W. L. MCATEE; *Treasurer*, W. W. COOKE; *Councillors*, N. HOLLISTER, J. W. GIDLEY, WILLIAM PALMER, ALEX. WETMORE, E. A. MEARNS.

President Hay was elected as the Society's representative upon the board of the Washington Academy of Sciences.

The president announced the following committees: *Committee on Publications:* N. HOLLISTER, W. L. MCATEE, W. W. COOKE; *Committee on Communications:* WM. PALMER, ALEX. WETMORE, LEWIS RADCLIFFE, J. W. GIDLEY, WILLIAM R. MAXON, H. S. BARBER.

M. W. LYON, JR., *Recording Secretary.*

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